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Effects of Repeated Instruction on Inhalation Therapy, Medication Adherence and Health Status in Chronic Obstructive Pulmonary Disease

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Abstract **Objectives:** The aim of this study was to systematically assess the impact of repeated instructional interventions on enhancing inhaler technique, medication adherence and quality of life for individuals with COPD. **Method:** This was a single-centre, randomized pre-post interventional study design that was applied in three consecutive weeks during September, 2024 to March, 2025. The study participants included 128 patients diagnosed with COPD defined as per GOLD guideline. Study participants randomly assigned to intervention (64 participants) and control group (64 participants). Primary outcomes were improvement in the inhaler technique assessed by 12-item checklist and medication adherence assessed by Medication Adherence Report Scale (MARS-5). Secondary outcome was enhancement of health-related quality of life assessed by COPD assessment tool (CAT). **Result:** The inhaler score was calculated as the proportion of the number of correct steps to the total number of steps. Participants in the intervention group exhibited significant improvement across all steps ($P < 0.00$), whereas participants in the control group continued to make almost similar errors ($P = 0.167$). Overall, participants reported poor adherence prior instruction program in both group with mean (SD) of 11.8 (2.4) and 11.7 (2.3) respectively. The score has significantly improved post program to mean (SD) of 18.8 (1.67) among intervention participants, while among control participants the mean (SD) slightly reduced to 11.5 (2.22). Repeated instruction and proper adherence to the medication significantly improved the quality of life, as assessed by the CAT mean (SD) from 28.2 (6.5) to 15.9 (4.3) ($P < 0.001$) in the intervention group. While in the control group mean (SD) of CAT score slightly increased from 27.8 (6.3) to 28.2 (6.1). **Conclusion:** An individualized repeated instruction intervention, in stable patients with COPD, in real-world clinical practice conditions, improves inhaler technique and adherence to the inhaled treatment and ultimately improves health related quality of life.

Key Words Inhaler Technique, Medication Adherence, COPD, HRQL

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a complex and progressive respiratory disease that significantly impacts global health, affecting millions of individuals worldwide. World Health Organization in November, 2024 reported that (COPD) is the fourth leading cause of death worldwide, causing 3.5 million deaths in 2021, approximately 5% of all global deaths [1]. Based on Burden of Obstructive Lung Disease (BOLD) the prevalence of COPD in global is estimated to be 10.3% [2]. The disease is characterized by persistent airflow limitation and respiratory symptoms. COPD is associated with a substantial decline in health-related quality of life, increased morbidity and higher healthcare expenditures [3].

Effective management of COPD primarily relies on pharmacological treatments, including the use of inhalation therapy, which could be complex to use correctly [4].

The optimal drug delivery to the lungs in the management of COPD relies on the selection of appropriate device for patients and adherence to prescribed medication regimens [5]. Inhaler technique and adherence pose significant challenges in COPD care; it is estimated that only 30% to 50% of COPD patients adhere to the treatment [6]. A systematic review published in 2016 found that merely 31% of patients are able to use inhaler correctly [7]. Unfortunately, the quality of inhaler technique has not shown improvement over the past 40 years. Since the introduction

of pressurized metered-dose inhalers (pMDIs) in the 1960s, subsequent devices have emerged, including dry powder inhalers (DPIs) and Respimat Soft Mist inhalers (SMIs) [8].

Despite advancements in inhaler technology, availability of effective treatments and support tools designed to enhance coordination, the challenge of improper inhaler technique persists in everyday practice as many patients struggle with proper inhaler technique and consistently taking their medications as directed, leading to suboptimal health outcomes, poor quality of life, poor medication adherence and increased healthcare costs [9]. In response to these challenges, repeated instruction approaches have emerged as a pivotal solution aimed at improving patients' understanding and execution of inhaler usage [10]. These programs provide comprehensive training and individualized support, equipping patients with the knowledge and skills necessary to optimize their inhalation techniques and enhance medication adherence. By empowering patients to take control of their treatment, repeated instruction not only improve clinical effectiveness but also promote a proactive approach to managing respiratory health with long-term outcomes and reduce hospitalization [9].

The existing body of evidence suggests that educational interventions can positively influence medication adherence and clinical outcomes for COPD patients. However, most current research emphasizes short-term educational interventions that are mostly provided by physicians or pharmacists, thus limiting our understanding of the long-term impact of repeated instruction provided by nurses on adherence rates and subsequent health status improvements.

In Erbil, data regarding inhaler technique and treatment adherence among COPD patients remains scarce. Furthermore, local health systems in Erbil-Kurdistan region have not adequately prioritize or implement such instructional strategies so far, thereby exacerbating the challenges faced by COPD patients in terms of self-management and treatment adherence. To address these gaps, the objectives of this study was to systematically evaluate the influence of repeated instructional interventions on improving inhaler technique, medication adherence and improving the quality of life for individuals living with COPD in Rizgary Teaching Hospital, Erbil City - Kurdistan region.

METHODS

Study Design

This was a single-centre, non-randomized pre-post behavioural interventional study design that was applied in three consecutive weeks during September, 2024 to March, 2025 for patients with COPD defined as per GOLD guideline [11]. TREND statement checklist is used to report this intervention study [12].

Subjects

A total of 128 outpatients with COPD were recruited during their monthly visit at respiratory unit of Rizgary Teaching Hospital in Erbil City. To choose patients, a purposeful sampling was used, then randomly assigned to intervention and control group. The researchers used a set of inclusion and exclusion criteria to find appropriate participants in order to ensure sample homogeneity. All patients were in stable condition. The recruitment is based on the following criteria: age ≥40, current or former smoker (≥10 Years), prescribed inhaled medicine for at least 12 months and no changes in the inhaler medicine for the last three months. The diagnosis of COPD was clinically confirmed by pulmonologists and spirometry. Patients with cognitive or fine motor skill impairment and recently diagnosed with COPD were excluded from the study.

Instruments of Data Collection

Socio-demographic characteristics were collected with a constructed survey questionnaire that included data regarding; age, sex, economic status, level of education and BMI. Medical data included the presence of comorbidities, duration of COPD, types of inhaler medication, doses per day, type of inhaler device and GOLD category.

The inhaler technique was assessed on the recruitment day with 12-item questionnaire tools for DPI- dry powder inhaler; MDI- metered dose inhaler; SMI – soft mist inhaler. Correct step was given score one and incorrect step was given zero. Proper use of inhaler was defined by not missing or not doing any step incorrectly. Improper use of inhaler was defined as missing or doing at least one step incorrectly.

Medication adherence was assessed by Medication Adherence Report Scale (MARS-5) [13]. This is generic self-reported measures adherence that evaluates intentional and unintentional non-adherence behaviours. First statement addresses non-intentional and the remaining four statements address intentional nonadherence behaviour. Participants were asked the following question; Do you ever forget to take medication? Do you sometimes stope taking medication, when you feel better? Do you ever skip taking medication? Have you ever used medication less than prescribed? Do administer far less what the doctor prescribed for you? Each question is answered on a scale of 1 to 5, where 1 represents "always," 2 represents "often," 3 represents "sometimes," 4 represents "rarely," and 5 represents "never". The score of the scale ranges from 5 to 25, where a higher MARS-5 score indicates higher self-reported adherence [14]. A score of 20 or higher has been used as a cutoff for adherence in some studies [15].

COPD assessment tool (CAT) was used to assess health-related quality of life. The self-reported CAT tool consists of eight questions designed to assess the impact of COPD symptoms on specific areas of life, such as cough, phlegm, chest tightness, breathlessness, activity limitation, confidence, sleep and energy. Each area scored from 0 to 5, with a total score ranging from 0 to 40. Higher scores indicate a greater negative impact of COPD on health and well-being [16]. Analyses were also conducted to profile patients with COPD stratified by the 4 impact categories derived from the CAT scale [16]. Patients were categorized into the following 4 groups based on their baseline CAT scale score: Low Impact (CAT < 10); Medium Impact (10 ≥ CAT ≤ 20); High Impact (20 > CAT ≤ 30); and Very High

Impact (CAT > 30). Baseline CAT impact categories were compared to patients' baseline clinical CAT statuses.

Description of the Repeated Instructional Sessions per The TIDieR [17]

The repeated instruction sessions were guided by the Theory of Planned Behaviour (TPB) which uses positive attitude, subjective norm and perceived behavioural control to predict intention, which then influences medication adherence and inhaler technique [18].

To address errors in inhaler technique eligible participants who provided informed consent were asked by the trained researchers to demonstrate their inhalers usage and the session plan was tailored to the errors identified. Short-term and long-term goals were established based on the patients' need. Participants received individualized instruction during the clinic visit (20-30 minutes per session, 3 sessions) at Respiratory unit-Rizgary teaching hospital. On the other hand, baseline information was obtained from control group, no instruction was provided to them by the researchers. Control group received routine care by the primary care provider and unit staff.

How TPB was Implemented

Fostering Positive Attitudes: Throughout the sessions, multiple factors were identified that decreased medication adherence ultimately led to reduced proper inhaler technique which included a lack of confidence in the medication, the economic status, polypharmacy, advanced age, living alone and literacy level. In the session constructive knowledge was provided regarding COPD pathophysiology, the benefits of inhalers and the consequences of neglecting the inhalers. Permission was obtained from primary care providers to substitute expensive inhalers brands with alternatives that had the same pharmaceutical action.

Influence Subjective Norms

The researchers created supportive environment by linking participants with the one who successfully mastered inhaler technique and medication adherence. Each participant had at least one group session to express negative feeling and how to overcome barriers. Moreover, family member was actively involved in the instructional program.

Enhance Perceived Control

Participants offered structured manual that was prepared to their literacy level. In addition, researchers demonstrated the proper way of inhalation in front of the participants, complemented by repeated illustrations and videos till the identified errors were corrected and the participants reached an acceptable technique. Patients were informed about the presence of QR codes on some inhalers and how to use them. The researchers used "teach-back" method to reach the identified goals [19].

Statistical analysis

All data were analysed using SPSS for Mac V.27 (SPSS Inc., Chicago, IL). Results are given as mean (± SD) or median values for quantitative variables, while frequencies were used for categorical variables. Paired samples *t*-test was used after testing normality distribution to find the difference between pre-post intervention. The level of significance was set at *P,* 0.001.

RESULTS

Table 1 presents the baseline characteristics of the intervention and control groups at the initial visit. The study population predominantly comprised middle-aged to elderly

Table 1: Comparison of Baseline Characteristic of the Intervention and Control Group

N (%)	Intervention (N = 64)	Control Group (N = 64)	P value
Age group			
41-50	10 (15.6)	12 (18.8)	0.894
51-60	23 (35.9)	21 (32.8)	
61-70	22 (34.4)	24 (37.5)	
71-80	9 (14.1)	7 (10.9)	
Gender			
Male	64 (100)	64 (100)	1.000
Educational level			
Illiterate	13 (20.3)	15 (23.4)	0.669
Able to read and write	51 (79.7)	49 (76.6)	
BMI			
Normal weight (18.5-24.99)	18 (28.1)	20 (31.3)	0.932
Overweight (25-29.99)	21 (32.8)	21 (32.8)	
Obese (30-34.99)	20 (31.3)	17 (26.6)	
Extremely obese > 35	5 (7.8)	6 (9.4)	
Income in regard with disease expenditure			
Sufficient	12 (18.8)	14 (21.9)	0.763
Barley sufficient	28 (43.8)	24 (37.5)	
Insufficient	24 (37.5)	26 (40.6)	
Number of comorbidities (median)	3 (1-5)	3 (1-5)	1.000
COPD duration, mean (SD), years	10.06 (4.1)	9.29 (3.7)	0.957
Bronchodilators			
LAMA	11(17.2)	10 (15.6)	0.909
LABA+ICS	20 (31.3)	18 (28.1)	
LAMA+LABA	10 (15.6)	13 (20.3)	
LABA+LAMA+ICS	23 (35.9)	23 (35.9)	
Inhaler devices			
Diskus® DPI	18 (17.7)	14 (22.2)	0.748
Symbicort Turbohaler® DPI	2 (3.2)	4 (6.3)	
Spiriva Handihaler® DPI	26 (41.9)	23 (36.5)	
Bufomix Easyhaler® DPI	3 (4.8)	5 (7.9)	
Foracort® MDI	7 (11.3)	10 (15.9)	
Salbutamol® MDI	3 (4.8)	3 (4.8)	
Spiriva Respimat® SMI	4 (6.5)	2 (3.2)	
Budesonide Easyhaler® DPI	5 (8.1)	6 (9.5)	
Number of inhalers			
One inhaler	30 (46.9)	31 (48.4)	0.860
Two inhalers	34 (53.1)	33 (51.6)	
Number of doses			
Single dose	36 (56.3)	34 (53.1)	0.723
Multiple dose	28 (43.7)	30 (46.9)	
GOLD classification			
GOLD I (mild)	5 (7.8)	6 (9.4)	0.891
GOLD II (moderate)	32 (50)	35 (54.7)	
GOLD III (severe)	24 (37.5)	21 (32.8)	
GOLD IV (very severe)	3 (4.7)	2 (3.1)	

Results expressed as number (%), median and mean ± standard deviation, BMI, body mass index; DPI, Dried Powdered Inhaler; MDI, Metered-Dose Inhaler; SMI, Soft Mist Inhalers; LAMA, Long-Acting Muscarinic Antagonist; LABA, Long-Acting Beta-Agonists; ICS, Inhaled Corticosteroid. GOLD, Global Initiative for Chronic Obstructive Lung Disease

Table 2: Comparison of Correct Inhaler Technique Between Intervention and Control Group

Paired Samples Test							
Groups		N	Mean (SD)	Mean Differences	t	df	P-value
Intervention group	Pre-intervention	64	8 (1.2)	-3.2	-15.23	63	<0.001
	Post-intervention		11.2 (1)				
Control group	Pre-intervention	64	7.9 (1.3)	-0.08	-1.39	63	0.167
	Post - intervention		8 (1.4)				

Table 3: Comparison of MARS-5 Between Intervention Group and Control Group

Paired Samples Test							
Groups		N	Mean (SD)	Paired Mean Differences	t	df	P-value
Intervention group	Pre-intervention	64	11.8 (2.4)	-7.03	-19.25	63	<0.001
	Post-intervention		18.8 (1.7)				
Control group	Pre - intervention	64	11.7 (2.3)	0.203	2.34	63	0.022
	Post intervention		11.5 (2.22)				

Table 4: Comparison Of COPD Assessment Test™ (CAT) Between Intervention and Control Group

Paired Samples Test							
Groups		N	Mean (SD)	Paired Mean Differences	t	df	P-value
Intervention group	Pre-intervention	64	28.2 (6.5)	12.34	19.5	63	<0.001
	Post-intervention		15.9 (4.3)				
Control group	Pre - intervention	64	27.8 (6.3)	-0.45	-2.5	63	0.016
	Post intervention		28.2 (6.1)				

males, aged 41 to 80 years, mean SD 60.14 (9.2) years old. A significant proportion of participants demonstrated good literacy levels, with 79.7% in the intervention group and 76.6% in the control group. Regarding body mass index (BMI), the highest percentage of participants in both groups were classified as overweight (32.8%). Participants exhibited varying levels of income adequacy, with 43.8% in the intervention group reporting that their income was barely sufficient to cover disease-related expenses, while 40.6% in the control group reported insufficient income. Most participants had multiple comorbidities, with a median of three and a prolonged duration of chronic obstructive pulmonary disease (COPD), with a mean (SD) duration of 10.06 (4.1) years in the intervention group and 9.29 (3.7) years in the control group. A variety of bronchodilator treatment regimens were prescribed, with the combination of long-acting beta-agonists (LABA), long-acting muscarinic antagonists (LAMA) and inhaled corticosteroids (ICS) being the most prevalent in both groups (35.9%). Spiriva Handihaler DPI was the most commonly used in both groups, with 41.9% in the intervention group and 36.5% in

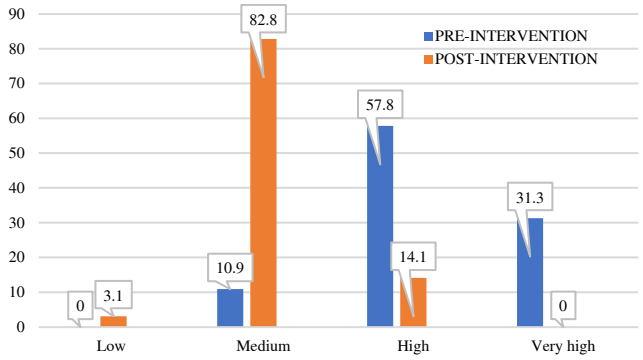

Figure 1: Impact of COPD on Health-Related Quality of Life (HRQL) of intervention group measured by CAT pre intervention and post intervention

the control group. More than half of the participants in both groups (53.1% and 51.6%) used more than two inhalers and a single dose per inhaler was common (56.3% and 53.1%). The severity of COPD among participants according to GOLD 2023 [11] was predominantly moderate (GOLD II), with respective percentages of 50% in the intervention group and 54.7% in the control group. The baseline characteristics of both groups were compared to assess the level of significance. The p-value indicated that there were no significant differences between the intervention and control groups across all variables.

Table 2 presents a comparison of inhaler skills before and after the intervention in both the intervention and comparison groups. The inhaler technique was evaluated prior to the repeated instruction program and following three instructional sessions using a 12-item checklist. The inhaler score was determined as the ratio of the number of correct steps to the total number of steps. Participants in the intervention group exhibited significant improvement across all steps ($P < 0.00$), whereas participants in the control group continued to make almost similar errors.

Table 3 shows the level of medication adherence measured by Medication Adherence Report Scale (MARS-5). Overall, participants reported poor adherence prior instruction program in both group with mean (SD) of 11.8 (2.4) and 11.7 (2.3) respectively. The score has significantly improved post program to mean (SD) of 18.8 (1.67) among intervention participants, while among control participants the mean (SD) slightly reduced to 11.5 (2.22).

Table 4 shows COPD Assessment Test™ (CAT) data analysis in both intervention and control group. Repeated instruction and proper adherence to the medication significantly improved the quality of life, as assessed by the CAT mean (SD) from 28.2 (6.5) to 15.9 (4.3) ($P < 0.001$) in the intervention group. While in the control group mean (SD) of CAT score slightly increased from 27.8 (6.3) to 28.2 (6.1). Previously explained that higher CAT score greater negative of COPD on the participants' quality of life.

Figure 1 shows CAT impact categories derived from the CAT scale pre intervention program and post intervention program. The analysis was only conducted for intervention

group. The figure does not show low impact in the pre-intervention as there were no patients in this category, however, 7 patients (10.9 %) were categorized as medium impact, 37 (57.8%) as high impact and 20 (31.3%) as very high impact. In the post-intervention, 2 patients (3.1%) were categorized as low impact, 53 (82.8 %) as medium impact and 9 (14.1 %) as high impact. No very high impact data recorded in the post-intervention.

DISCUSSION

In the pre-assessment repeated instruction program, all participants made critical errors in using their inhalers and almost no one showed a skilled inhaler technique. The overall score for the inhaler technique was low. Additionally, nonadherence occurred in all participants. These results negatively impacted quality life of the participants. This finding is consistent with the result of prior research of Sánchez-Nieto *et al.* [20]. Additionally, patients' dissatisfaction with suboptimal responses may be exacerbated by improper inhalation techniques, which can lead to poor medication adherence. Incorrect inhaler use technique and medication non-adherence were demonstrated to be associated with poor treatment outcomes among COPD patients [21].

The introduction of the repeated instruction program significantly improved inhaler treatment technique, medication adherence and overall quality of life. This was the first time patients received constructed instructions from nurses in Erbil City. All participants reported that they were first introduced to inhaler medication by a primary care provider. Schreiber *et al.* [8] observed fewer errors among 105 participants in a cross-sectional study if the structured patient education was provided by nursing staff than when structured patient education was done by a primary care provider.

Researchers in the previous studies have applied heterogeneous number of instruction session to minimize inhaler technique errors and increase adherence [5,9,20]. However, the required number of instruction session still unclear. Participants in this study received three repeated instructions to correct errors in all type of devices used by the participants. This finding is in accordance with another research showing that three necessary sessions are required to achieve less than 10% errors or entirely no errors [22].

Poor inhaler technique and low medication adherence have a direct impact on symptom control and the rate of exacerbations, ultimately resulting in a diminished quality of life. In a cross-sectional study involving 318 COPD patients undergoing inhaler treatment, López-Pintor found that health-related quality of life (HRQL) was significantly lower among participants with poor adherence. Enhancements in inhaler technique and medication adherence were found to significantly aid participants in managing their symptoms, thereby directly improving HRQL, as measured by the CAT. The highest score of CAT was 40, which was reduced to 25 ($P < 0.001$) post three-week sessions and shortness of breathing when walking up hill or stairs was the most reported symptoms.

Numerous studies have identified various factors influencing medication adherence and inhaler technique, including severity of the disease, the presence of comorbidities, polypharmacy, smoking status, socioeconomic factors, the complexity of the inhaler device and patients' perceptions of the treatment [6]. The present study also identified several factors during sessions that were expected to impact inhaler technique and adherence. However, no significant relationships were observed; consequently, the researcher chose not to present the data. A similar outcome was reported in a single-group study with intervention and before-after evaluation conducted by Sánchez-Nieto *et al.* [20].

The findings of the current study indicate several significant implications. Firstly, healthcare professionals should deliver explicit instructions to patients and their families regarding the procedures for inhaler use, emphasizing critical points that patients may overlook or forget. Additionally, patients should be encouraged to demonstrate the technique in the presence of medical staff for corrective feedback. Secondly, it is imperative for health professionals to regularly assess patients' inhaler usage and provide timely and appropriate counselling. The literature indicates that patients who receive inhalation instructions from healthcare workers exhibit superior technique compared to those who rely on self-study [20]. Lastly, further research is recommended to explore the multilevel factors, individual, familial and societal beliefs and perceived barriers, associated with medication adherence and inhaler use technique, to comprehensively support patients in managing and controlling COPD.

CONCLUSIONS

Despite limitations, our study gives preliminary data that counselling through direct demonstration and showed promising results in improving medication adherence, the proper inhaler technique and patients' quality of life. In summary, repeated constructed instruction are essential approach to enhance inhaler techniques and foster medication adherence. These programs lead to better health outcomes by empowering patients to effectively manage their respiratory conditions and enriching their quality of life.

Limitations

This study had some limitations that should be addressed. First, the sample size was small, which may have affected the outcomes of the study and the generalizability of the results. Second, we intentionally simplified and modified the 12-item checklist used to assess the inhaler technique to fit all types of devices. Although it was not our aim to assess the superiority of one device over another. Finally, the long-term effects of the instruction were not followed due to the time frame, as this study was a requirement for the PhD program.

Ethical Statement

The research protocol was approved by the Institutional Review Board of Hawler Medical University/College of

nursing on the first of September, 2024, Code N. 2464. The trial was registered at ClinicalTrials.gov. Trial number: NCT06954948. All participants were informed about the content, purpose and risk of the study and how their data will be kept confidential. Written informed consent was obtained from the participants.

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